REMARKS

Claim 16 has been objected to on the basis that the value of E has been incorrectly specified. Claim 16 has been amended to incorporate the value of E as described in the specification on page 7, line 14.

Claims 16, 17, 27, 28, 31, 32 have been rejected under 35 U.S.C. § 103 (a) as being unpatentable over Field on the ground that Field discloses or teaches all features of claim 16 except for the width of the minimum air-gap in the range as specified in claim 1, but that it would have been obvious to meet those criteria since the general conditions of the claim are disclosed in the prior art and the discovery of optimum or workable ranges involves only routine skill (citing re Aller, 105 USPQ 233).

This argument is incorrect, in the Applicants' opinion, for the following reasons. First, Field does not disclose a motor having a size enabling it to generate a maximum magnetic potential of about 1.7 x 10-4 J/μo ampere-turns, which for most magnetic materials is in the order of 270 to 300 ampere-turns. To the contrary, Field discloses a stepping motor with a data diameter of two inches, a rotor diameter of 1.5 inches and an axial length thereof of about 0.7 inches. Such motors, which may for example be used in floppy disk drives, are very small motors that have a magnetic potential significantly smaller than 270 ampere-turns and are therefore in a different class of motors than those to which the invention according to claim 1 and the dependent claims relate.

More importantly, however, the minimum air-gap width specified in claim 1 would not have been found by routine experimentation by the ordinary skilled person, since the claimed range teaches in the opposite direction to that of the prior art and of the established knowledge in the field of electrical motors. Prior to the present

invention, it was established knowledge that the width of the air-gap between two facing teeth in a motor should be as narrow as possible in light of the technical constraints that stem from manufacturing tolerances in terms of diameter, concentricity, centering, and other sources of inaccuracy. The Examiner is directed to the references mentioned in the passage from page 2, line 24, to page 6, line 23 of the present application. In the aforementioned passage, the established knowledge in the art is clearly set out, and the Examiner has not provided any reference to any prior art that shows the contrary. In the present invention, the air-gap width set forth in the range specified in claim 1 is larger than conventional air-gaps provided in prior art motors that depend only on manufacturing and other technical constraints, as discussed above. Therefore, considering that the established knowledge is to minimize the air-gap to the aforementioned technical constraints, an ordinary skilled person would not seek to increase the air-gap in order to increase torque and performance, but would do exactly the opposite. The conditions for applying re Aller to argue that claim 16 is obvious over Field are therefore not satisfied.

Moreover, as discussed above, Field does not disclose a motor of the same class as the motor according to claim 1.

For the same reasons, the use of re Aller to argue that claims 17, 27, 31 and 32 are obvious over Field does not apply, since these claims teach against the prior art and established knowledge in the field such that an ordinary skilled person would not have obtained the claimed values by routine experimentation.

The Applicants further remark that there are exceptions to the rule set forth in re Aller, and Applicants refer the Examiner to re Sebek, 465 F.2d 904,907, 175 USPQ 93,

95 (CCPA 1972) where it is stated that "while it may ordinarily be the case that determination of optimum values for parameters of a prior art process would be at least prima facie obvious, that conclusion depends on what the prior art discloses with respect to those parameters." The Examiner has not shown any disclosure teaching or suggesting to provide a motor with an air-gap in the range claimed in claim 1, which is larger than the minimum air-gap required for technical constraints, nor why one of ordinary skill in the art would experiment to increase the air-gap with respect to conventional air-gaps, to the range specified in claim 1, where the established general knowledge and teachings of the prior art would encourage the skilled person to do the opposite, to reduce the air-gap to the minimum required for manufacturing and other technical constraints.

Claim 20 has been rejected by the Examiner on the basis of Fields and Brigham.

Claim 20, which depends on Claim 16, differs from Field and Brigham, not only with respect to the differences already discussed previously, but also in that Brigham discloses semi-circular hollows between the stator teeth. The Applicants contest the Examiner's assertion that Brigham discloses hollows that are essentially of parabolic shape. Since there is no teaching of parabolic hollows in Brigham, and considering that conventional hollows between teeth, to the Applicants' knowledge, are semi-circular, there is no teaching or suggestion in Brighm of essentially parabolic hollows between teeth. As discussed in the present application, the parabolic shape is particularly advantageous when in the presence of high induction, since the loss of magnetic potential in the tips of the teeth is significantly reduced while having good depth for the teeth.

Considering that essentially parabolic teeth are significantly more difficult to manufacture than semi-circular or essential square indents, in order for a person of ordinary skill in the art to modify Brigham or Field to form rotor teeth with parabolic-shaped indents, the prior art would have to teach that a parabolic indent would have the advantages discussed above. The Examiner, however, has not identified any teaching that would encourage the person of ordinary skill in the art to provide essentially parabolic indents in the motor according to Field.

The same reasoning applies to Claim 21, whereby the prior art identified by the Examiner does not suggest or disclose parabolic-shaped indents between the stator teeth.

Concerning the rejection of Claims 22-25 on the workable range of the angle formed between the tangents to the profile of the teeth, as being unpatentable in view of re Aller, the Applicants are of the opinion that the conditions for applying re Aller have not been satisfied. In order for re Aller to be applied, the general conditions of the claim should be disclosed in the prior art. Moreover, the parameter to be optimized must first be recognized as a result-effective variable. The Examiner has, however, not established or shown any prior art that identifies the angle of the tangent of a tooth profile to be recognized as a result-effective variable. It therefore cannot be argued that the determination of the workable range of the angle will be characterized as routine experimentation. <u>Re Antonie</u>, 559 F.2d 618, 197 USPQ 6 (CCPA 1997) and <u>re Boesch</u>, 617 F.2d 272,205 USPQ 215 (CCPA 1980).

Claims 18 and 19 are rejected as being unpatentable over Field in view of Takura on the ground that Field shows all the limitations of the claimed invention,

except showing the width E of the air-gap is greater than 1.2 x 10-4 m, but that Takura discloses a device wherein the width E of the air-gap is greater than 1.2 x 10-4 m.

The Examiner's interpretation of Takura is, however, believed to be incorrect for the following reason.

Takura discloses a device with an air-gap of 0.2 mm (column 6, lines 36-53, and column 10, lines 6-16). The specified range ± 1 mm does not relate to the width of the air-gap, but the range in the circumferential direction about the mid-point where the side in points E and G are facing each other at ± 0. It is clear from the passages cited above that the range of ± 1 mm does not relate to the air-gap. If such were the case, this would mean that the air-gap would have a range of - 1 mm to 1.2 mm, which is clearly impossible. As can be seen in column 6, lines 42-46, the range of ± 1 mm is explained with reference to the convex poles 4a and 4c, which may be deviated by about 1 mm to the inside of the magnetic poles 2a and 2d, and all the convex poles may be deviated by about 1 mm to the outside of the magnetic poles. The deviation of values of 1 mm "inside" and "outside" within the context of the description according to Takura clearly relates to the circumferential overlap of the corner points (a positive overlap meaning "inside" and a negative overlap meaning "outside").

Moreover, Takura does not disclose a motor having a size enabling it to generate a maximum magnetic potential of about 1.7 x 10-4 J/μo. This can be deduced from the torque that is inferior to 0.05 Nm, as shown in Fig. 9, and the speed (around 50000 rpm as discussed in column 8, line 25), which the Applicants would estimate as meaning a motor with a maximum magnetic potential probably in the order of 80 to 120 At, but in any case less than 270 At.

Therefore, Takura does not disclose the features of claims 18 and 19, and moreover, Field does not show all the limitations of the claimed invention according to claim 16, as discussed previously, on which claims 18 and 19 depend.

Claim 30 is rejected as being unpatentable over Field in view of Bahn, and further in view of Horst, on the basis that Field and Bahn show all limitations of Claim 30, except that the ends of the stator pole pieces are curved with a radius such that the air-gap between the teeth is of varying width, whereas Horst discloses a device in which an end of a stator pole piece is curved to the radius, such that when the teeth of the stator and rotor face each other, the air-gap between them varies in width. The Applicants however believe that this interpretation of the prior art is incorrect.

First, as was already discussed previously, Field does not disclose essential limitations of Claim 16, on which Claim 30 depends. Second, Horst does not disclose a device wherein an end of a stator pole piece is curved with a radius such that when the teeth of the stator and rotor are facing each other, the air-gap between is of varying width. Horst does disclose a rotor with a step in the rotor teeth (for example as shown in Figures 6, 7 and 10a), such that the air-gap has a non-constant width. According to Claim 30, however, the end of the stator pole piece is curved with the radius such that when the teeth of the stator and rotor are facing each other, the air-gap between them is of varying width. In Horst, the varying width results from a step and not from a radius curvature. Horst therefore does not disclose the feature according to Claim 30. Moreover, the step in Horst addresses the problem of reducing harmonics (see page 21, lines 3-12 of the application) and not of improving torque as in the present invention.

Claims 26 and 29 depend from Claim 16, and are thus also patentable for the foregoing reasons.

In view of the above, Applicants believe that the objections and rejections have been traversed and Claims 16 to 32 are allowable over all the prior art of record.

Attached hereto is page 10 that presents a marked up version of the changes made to claim 16 of the application by the current Amendment. Page 10 is captioned "VERSION WITH MARKINGS TO SHOW CHANGES MADE."

Respectfully submitted:

By [signature]

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VERSION WITH MARKINGS TO SHOW CHANGES MADE

Claim 16 has been amended as follows:

16. (Amended) An electromagnetic device, that is a linear or rotary single- or multi-phase motor or generator, comprising, for each phase, at least two relatively-movable sets of teeth made of soft magnetic material, one set of teeth being associated with the stator and the other with the rotor, the device being of a size enabling it to generate a maximum magnetic potential U_{max} of about $1.7 \times 10^{-4} J/\mu_0$ ampere turns (At), wherein the width E of the minimum air-gap between teeth of the rotor and of the stator as measured in the direction perpendicular to their degree of freedom is approximately equal to or greater than:

the value $0.7[1 - 5 \times 10^{-4}(U_{max} - 1.7 \times 10^{-4} J/\mu_0)]\mu_0 U_{max}/J$
when $[1 - 5 \times 10^{-4}(U_{max} - 1.7 \times 10^{-4} J/\mu_0)] \geq 0.5$

or <u>E is approximately equal to or greater than</u> the value $0.35\mu_0 U_{max}/J$
when$[1 - 5 \times 10^{-4}(U_{max} - 1.7 \times 10^{-4} J/\mu_0)] < 0.5$

or that E is greater than 2×10^{-3} m;

where μ_0 is the permeability of a vacuum, U_{max} is the maximum generated magnetic potential difference for causing the magnetic field to pass through the air-gap E, said potential difference being due either solely to the ampere-turns of the coil(s) feeding the air-gap E, or to the sum of said ampere-turns plus the magnetic potential difference between the two sets of teeth in the absence of currents due to a permanent magnet, and where J is the maximum polarization of the soft magnetic material used for making the teeth.